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Original Article

PERFORMANCE EVALUATION OF VCR CI ENGINE USING C-D INTAKE MANIFOLD WITH INTERNAL GROOVING

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ABSTRACT

Compression ratio (CR) is a design parameter that influences efficiency, characteristics as well as emissions from the engine. Varying of Compression Ratio is done to increase fuel efficiency under varying loads. The experimental study is conducted on a four stroke VCR diesel engine of KIRLOSKAR make. The thermal performances are evaluated by operating the engine at different preset compression ratios (CRs) ranging from 12:1 to 20:1 and different injection pressures (IPS) of 150 bar, 200 bar And 250 bar and varying loads from 0 kg to 12 kg in steps of 3kg. The intake manifold of the VCR Engine is manufactured using mild steel in such a way that when air is passed through the manifold it gains velocity along with a swirl motion, due to the convergent and divergent manifold (C-D) with internal threading- Grooving. The swirl motion of the air helps in complete occupancy of the cylinder volume and when the fuel is injected, fuel mixes with the air uniformly due to which combustion of fuel will be maximum and the efficiency of the engine will increase. The C-D manifold is designed and tested for performance analysis in Solidworks and the results are evaluated.

KEYWORDS: Variable Compression Ratio, Convergent Divergent Manifold, Grooving, Swirling, Solidworks

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INTRODUCTION

The motto of this work is to evaluate the performance parameters of a VCR diesel engine with the Hibiscus-Diesel blend fuel. Worldwide increase of demand for diesel fuel and environmental emission control has led to considerable research for better fuel formulations and thus reduction in smoke and particle levels. However, it is difficult to achieve the required emission standards with engine improvements alone. Blending the diesel with different vegetable oils has proven to be an alternative method to achieve the low emission and better performance diesel combustion. This has been the focal point of most researchers in this field within the last two decades analysis using SOLIDWORKS.

In the grooving manifold the turbulence of air occurs, thereby swirl motion of the air will be created which results in homogenous mixture of air fuel ratio. The intermittent or pulsating nature of the airflow through the intake manifold into the cylinder may develop resonances in the airflow at certain speeds. Based on dimension and shape of the manifold, engine performance parameters can be increased at particular engine speeds. Air motion in CI engine influences the atomization and distribution of fuel injected in the combustion chamber and also supplies fresh air to the interior portion of the fuel drops and thereby ensures complete combustion.

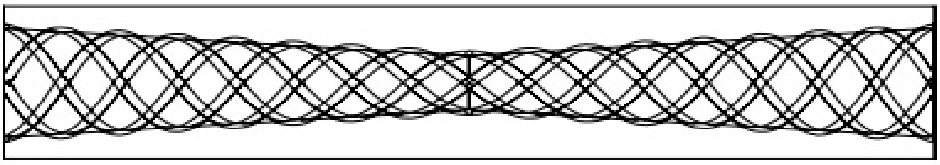


Figure: Convergent Divergent Manifold with Internal Grooving

C-D MANIFOLD MATERIAL PROPERTIES

- The modulus of elasticity calculated for the industry grade mild steel is 210,000 Mpa. It has an average density of about 7860 kg/m^3.
- Mild steel is a great conductor of electricity.
- Mild steel can be easily machined in the lathe, shaper, drilling or milling machine. Its hardness can be increased by the application of carbon.

EXPERIMENTAL PROCEDURE

Diesel alone is to run the engine for about 30 min under the compression ratio of 16.5, so that it gets warmed up and steady running conditions are attained. Before starting the engine, the lubricating oil level in the engine is checked and it is also ensured that all moving and rotating parts are lubricated. The engine was started and allowed it to settle at rated speed. The load was applied by adjusting the potentiometer to the desired load.

The following parameters are to be evaluated for checking the performance of the engine equipped with internally grooved C-D intake manifold.

Measurement of Brake Power

Measurement of Fuel

Measurement of Air Flow

Load on the Engine

Then all the required parameters would be jotted down viz., Speed of the engine from Digital RPM indicator, Load from the load indicator, Fuel consumption from the burette, Quantity of air flow from the manometer, Different temperatures from temperature indicator, The engine was loaded in a stepwise manner, Thereafter, the corresponding parameters were noted. The procedure was repeated for different compression ratios (14.5, 16.5, and 17.5).

Modelling & Design

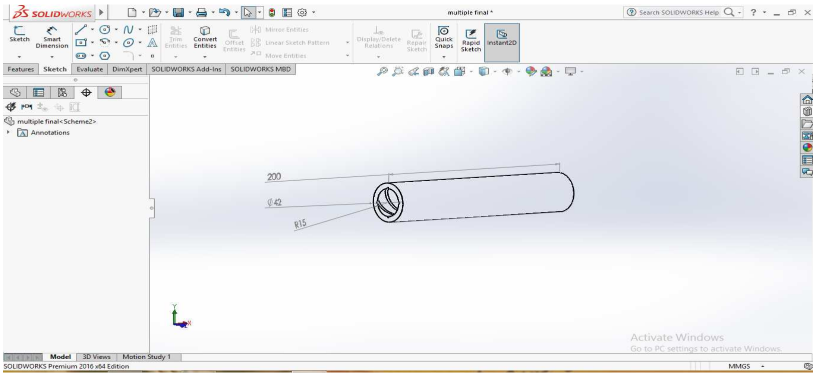


Figure: Modeling of Convergent-Divergent Manifold with Internal Profile Grooving

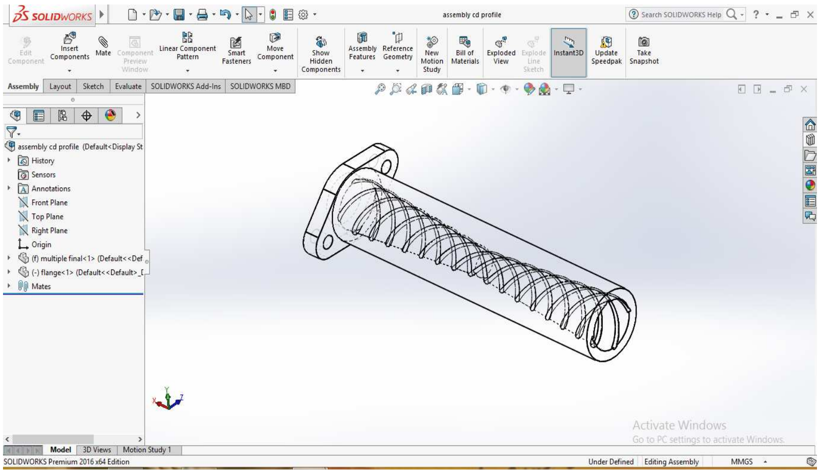


Figure: Assembled Model of C-D Manifold with Internal Profile Grooving and Clamp

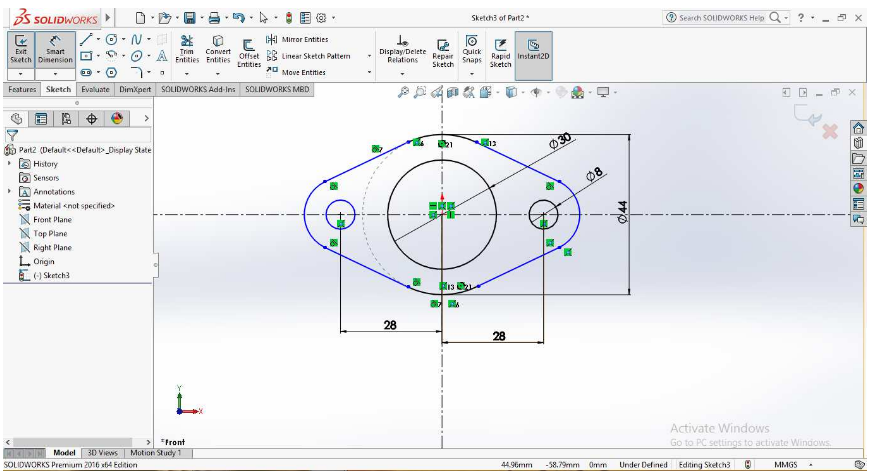


Figure: 2D Modeling of Manifold Clamp

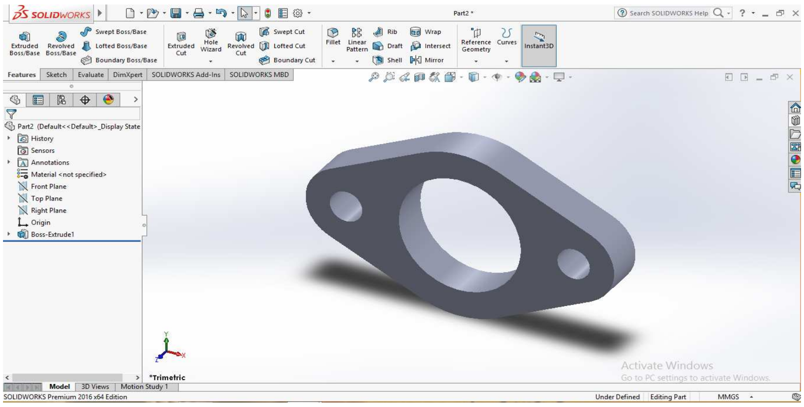


Figure: 3D- Modeling of Manifold Clamp

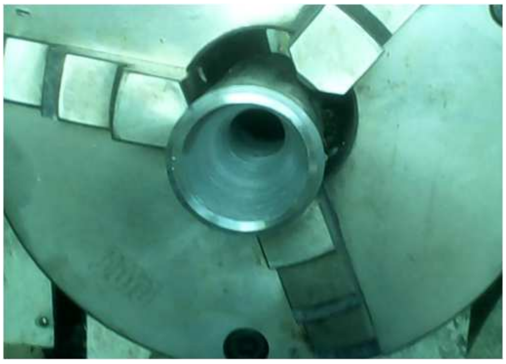


Figure: Convergent Divergent Manifold

Table: Performance Test on Stock Manifold at Compression Ratio 14.5

Load (kg)	Speed (N)	T1 (°C)	T2 (°C)	T3 (°C)	T4 (°C)	T5 (°C)	Time (sec) 10cc	H1 (mm)	H2 (mm)
0	1560	30	33	31	140	75	49	11	14
2	1552	30	35	31	186	83	43	11.1	14.2
4	1534	30	36	32	212	91	37	11	14.4
6	1508	30	37	32	238	100	30	10.9	14.5

Table: Performance Test on C-D Manifold with Internal Grooving at Compression Ratio 14.5

Load (kg)	Speed (N)	T1 (°C)	T2 (°C)	T3 (°C)	T4 (°C)	T5 (°C)	Time (sec) 10cc	H1 (mm)	H2 (mm)
0	1558	29	31	29	102	56	48	11	15
2	1552	29	33	29	145	65	42	11	15.5
4	1532	28	34	29	175	73	34	11	15.5
6	1516	28	34	30	205	83	30	11	16.5

Table: Performance Test Results on Stock Manifold at Compression Ratio 14.5

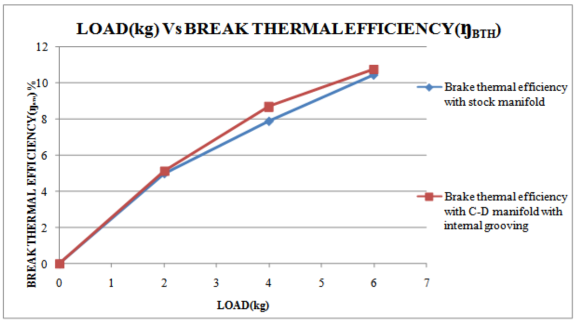
Load (kg)	Brake Thermal Efficiency (ŋ)	Mechanical Efficiency (ŋ)	Indicated Thermal Efficiency (ŋ)	Volumetric Efficiency (ŋ)	Mass of Fuel Consumption (kg/hr)	Specific Fuel Consumption (kg/Kw-hr)
0	0	0	28.36	20.2	0.60	0
2	4.99	14.99	28.19	21.22	0.69	1.71

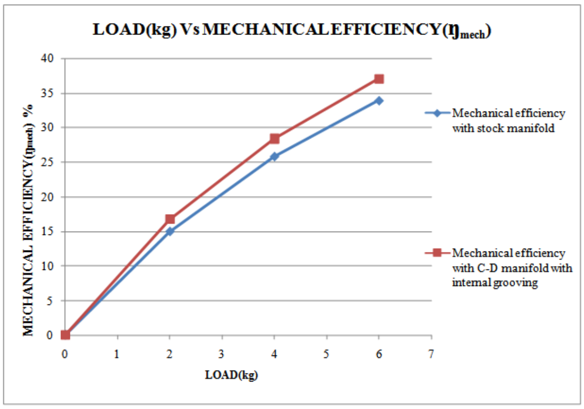
Table: Contd.,						
4	7.98	25.85	28.07	22.55	0.80	1.07
6	10.45	33.95	29.81	23.64	0.99	0.82

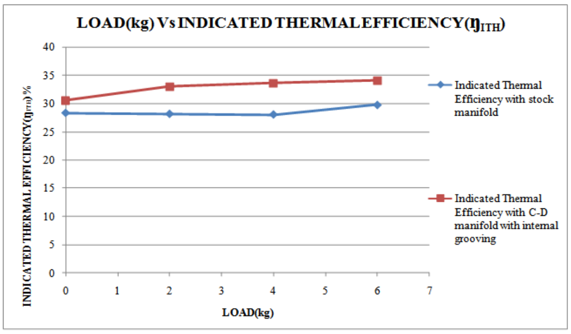
Table: Performance Test Results on C-D Manifold with Internal Grooving at Compression Ratio 14.5

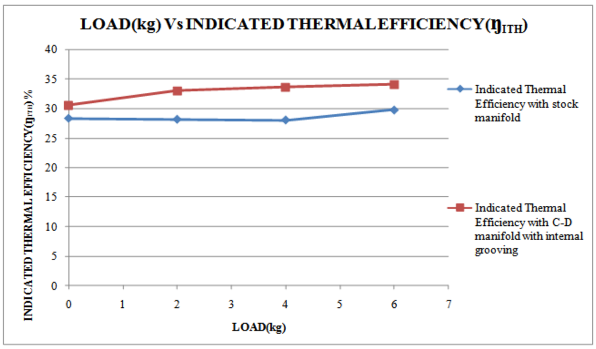
Load (kg)	Brake Thermal Efficiency (ŋ)	Mechanical Efficiency (ŋ)	Indicated Thermal Efficiency (ŋ)	Volumetric Efficiency (ŋ)	Mass of Fuel Consumption (kg/hr)	Specific Fuel Consumption (kg/kW-hr)
0	0	0	30.62	34.76	0.62	0
2	5.11	16.75	33.03	37	0.71	1.64
4	8.69	28.42	33.64	37.49	0.87	0.98
6	10.76	37.09	34.10	41.89	0.99	0.81

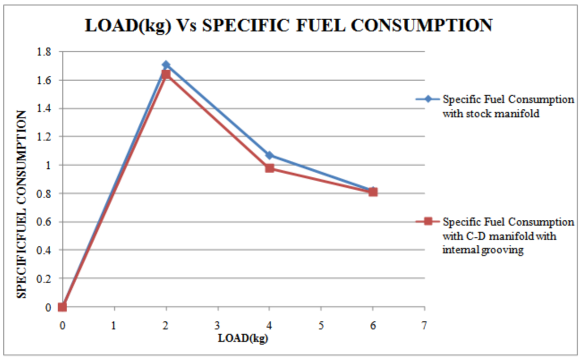
At Compression Ratio 14.5











CONCLUSIONS

Based on the present experiment and computational work, we can conclude that Convergent-Divergent manifold with internal grooving plays a significant role in deciding the performance of the engine.

The optimum Compression Ratio is 17.5 for the Convergent-Divergent manifold with internal grooving. For more power and at high loads, the engine should operate at Compression Ratio 17.5 due to less Specific Fuel Consumption. Also that the exhaust gas temperatures are high it indicates proper atomization of fuel due to which high power output is obtained.

The performance characteristics using Convergent-Divergent manifold with internal grooving over stock manifold shows a significant increase in efficiencies. By this, it shows that Convergent-Divergent manifold with internal grooving has better performance over the stock manifold.

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